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09/504,623	02/15/2000	Kazuhito Tsukagoshi	2369/25	8134

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EXAMINER
DOLAN, JENNIFER M

ART UNIT	PAPER NUMBER
2652	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/504,623	Applicant(s) TSUKAGOSHI ET AL.
	Examiner Jennifer M. Dolan	Art Unit 2652

-- The MAILING DATE of this communication appears on the cov r sh et with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-25 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-25 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 5 .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 8 and 24 are rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,726,837 to Nakatani et al. (cited by applicant).

Regarding claim 8, Nakatani et al. disclose a magnetoelectric device responsive to an applied magnetic field (figure 2, column 6, lines 62-64). The device comprises first (37) and second (39) ferromagnetic regions with a channel region (38) between them (figure 16) wherein the channel region includes a carbon containing material (column 17, lines 7-9).

Regarding claim 24, Nakatani et al. disclose a magnetic head for reading data from magnetic storage media (column 1, lines 9-14).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1 and 18-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,654,566 to Johnson in view of U.S. Patent No. 5,365,078 to Hayashi et al.

Regarding claim 1, Johnson discloses a magnetoelectric device responsive to an applied magnetic field (column 7, line 67- column 8, line 3), comprising first (110) and second (116) ferromagnetic regions with a channel region (112) between them (figure 4). The ferromagnetic regions are configured so that charge carriers with a particular spin polarization which can pass through the first region, pass through the second region as a function of the relative orientations of magnetization of the ferromagnetic regions produced by the applied magnetic field (column 10, lines 17-21 and column 7, line 64-column 8, line 3). Because the strength of the applied field directly determines the degree to which the ferromagnetic field (116) magnetically aligns with the external field, and because the conductivity varies with the orientation of the second ferromagnetic region (116) relative to the first ferromagnetic region (110) (column 10, lines 17-21), it is an inherent property of the magnetoelectric device of Johnson that the conductivity is a function of the strength of the applied field. Johnson further discloses a quasi-two-dimensional channel (column 11, lines 12-17) to cause charge carriers that pass through the first ferromagnetic region to maintain their spin polarization as they pass toward the second region (column 10, line 60-column 11, line 17).

Johnson fails to teach a quasi-one-dimensional channel.

Hayashi et al. teach a quasi-one-dimensional channel (column 6, lines 16-24).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the magnetoelectric device of Johnson to include the quasi-one-dimensional channel taught by Hayashi. The rationale is as follows: One of ordinary skill in the art at the

time the invention was made would have been motivated to provide a quasi-one dimensional channel because a higher speed and lower noise operation can be achieved by using a quasi-one-dimensional channel rather than a quasi-two-dimensional channel (Hayashi, column 6, lines 22-24).

Regarding claim 18, Johnson discloses that the first and second ferromagnetic regions comprise layers on a common substrate (figure 2).

Regarding claim 19, Johnson discloses a substrate (204) made of silicon (column 11, line 58), covered with an insulating layer (202) on which the ferromagnetic layers are formed (figure 6b).

Regarding claim 20, Johnson teaches that the insulating layers are made of a silicon oxide (column 11, line 57).

Regarding claim 21, Johnson further discloses that the first and second ferromagnetic layers are made of a cobalt containing material (column 12, lines 13-15 and 37-39).

Regarding claim 22, Johnson discloses a gate (206) to apply a field to a channel region (column 11, line 63-column 12, line 2).

Regarding claim 23, Johnson discloses a magnetic reading head for reading data from magnetic storage media (column 8, lines 4-6).

5. Claims 2-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Johnson in view of Hayashi, as applied to claim 1, above, and further in view of Journal of Experimental and Theoretical Physics article written by Tsebro et al. (cited by applicant).

As per claim 1, Johnson in view of Hayashi discloses the claimed invention (see section 4, supra).

Regarding claim 2, Johnson as modified by Hayashi fails to disclose the use of a nanotube in the channel region.

Tsebro teaches that a nanotube is a quasi-one-dimensional structure (column 3, lines 12-16) which is used as an electric transport material (column 1, lines 1-2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the magnetoelectric device of Johnson as modified by Hayashi by including nanotube channels, as taught by Tsebro. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide a carbon nanotube as the quasi-one-dimensional structure of Johnson as modified by Hayashi, because a carbon nanotube is a common quasi-one dimensional structure (column 3, lines 12-16) with a relatively high conductivity (Tsebro, column 2, lines 1-3) and mobility. Thus, the carbon nanotube provides desirable characteristics for the channel region (Johnson, column 10, lines 15-17).

Regarding claim 3, Johnson as modified by Hayashi fails to disclose a bundle of nanotubes.

Tsebro discloses a bundle of nanotubes (column 1, line 8).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the device of Johnson as modified by Hayashi by adding the bundle of nanotubes taught by Tsebro. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide a bundle of nanotubes in the channel region of Johnson as modified by Hayashi because a single nanotube has a small

volume, and thus does not allow for the transport of a large number of charge carriers. A nanotube bundle increases the volume of the channel transport region and thus decreases the resistivity of the channel region and increases the device speed while retaining the fermionic waveguiding properties of a quasi-one-dimensional material.

Regarding claim 4, Johnson as modified by Hayashi fails to disclose a nanotube made of carbon.

Regarding claim 5, Johnson as modified by Hayashi fails to disclose a quasi-one dimensional channel made of a carbon-containing material.

Tsebro discloses a carbon nanotube (column 1, lines 1-2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the device of Johnson as modified by Hayashi to include a carbon nanotube, as taught by Tsebro. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to specify that the nanotubes are made of carbon, as taught by Tsebro, because carbon nanotubes provide conductivity and transport characteristics suitable for channel materials (Tsebro, column 2, lines 1-3 and column 3, lines 36-38).

Regarding claim 6, Johnson as modified by Hayashi fails to disclose that the channel region comprises a layer of graphite.

Tsebro teaches that the carbon nanotubes comprise a layer of graphite (column 3, lines 21-23).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the device of Johnson as modified by Hayashi by including a

graphite layer in the channel, as taught by Tsebro. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide a layer of graphite in the carbon nanotube, as taught by Tsebro, because the evaporation of graphite in an electron beam is a simple and known means of fabricating carbon nanotube films (Tsebro, column 1, lines 22-23), and such a process of fabrication results in nanotube walls composed of a layer of graphite (Tsebro, column 3, lines 21-23).

Regarding claim 7, Johnson as modified by Hayashi fails to disclose the use of a layer of diamond.

Tsebro teaches the use of carbon layers in the channel region. Although the Bravais lattice structure of the carbon layers is not specified, the carbon layers are considered to encompass both graphite and diamond lattice structures. Assuming arguendo, the carbon layers taught by Tsebro do not include diamond.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify in the device of Johnson as modified by Hayashi, that the carbon layer taught by Tsebro has a diamond lattice. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to specify a diamond lattice material structure in the carbon layer taught by Tsebro, because the material lattice choice directly affects the structural and electrical properties of the material. This enables the material properties to be more specifically chosen and optimized for the material's intended use. One of ordinary skill in the art would additionally be motivated to choose diamond or graphite carbon layers in order to optimize lattice matching with the surrounding layers. Thus, it would have

been obvious to specify that the carbon layers include diamond, in order to select nanotube properties and promote lattice matching over a broad range.

6. Claims 9, 10, 13-15, and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakatani in view of Tsebro.

Regarding claim 9, Nakatani fails to disclose a carbon nanotube in the channel region.

Tsebro teaches the use of carbon nanotube (column 1, lines 1-2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include a carbon nanotube, as taught by Tsebro, in the magnetoelectric device of Nakatani. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide a carbon nanotube, as taught by Tsebro, because it is known in the art that a quasi-one-dimensional channel region prevents scattering in the channel region and provides fermionic waveguiding of carriers. This, in turn, results in higher speed and lower noise operation of the magnetoelectric device (see explanation, supra). Carbon nanotubes are a known quasi-one-dimensional structure (Tsebro, column 3, lines 12-16), which act as ideal channel regions due to their low resistivity at room temperature (Tsebro, column 3, lines 36-38). Thus, it would have been obvious to include a carbon nanotube in the channel region of the device of Nakatani to reduce scattering, and thus achieve higher speed and lower noise operation.

Regarding claim 10, Nakatani fails to disclose a bundle of nanotubes.

Tsebro discloses a bundle of nanotubes (column 1, line 8).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the device of Nakatani by adding the bundle of nanotubes taught by Tsebro. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide a bundle of nanotubes because a single nanotube has a small volume, and thus does not allow for the transport of a large number of charge carriers. A nanotube bundle increases the volume of the channel transport region and thus increases the device speed while retaining the fermionic waveguiding properties of a quasi-one-dimensional material.

Regarding claim 13, Nakatani teaches a magnetoelectric device responsive to an applied magnetic field (figure 2, column 6, lines 62-64) comprising first (37) and second (39) ferromagnetic regions with a channel region (38) between them.

Nakatani fails to disclose a nanotube.

Tsebro teaches the use of a nanotube (column 1, lines 1-2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include a nanotube, as taught by Tsebro, in the magnetoelectric device of Nakatani. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide a carbon nanotube in the channel region of Nakatani, because it is known in the art that a quasi-one-dimensional channel region prevents scattering in the channel region and provides fermionic waveguiding of carriers. This, in turn, results in higher speed and lower noise operation of the magnetoelectric device (see explanation, supra). Nanotubes are a known quasi-one-dimensional structure (Tsebro, column 3, lines 12-16), which additionally have low resistivity at room temperature (column 3, lines 36-38), which is an ideal

property for a channel region. Thus, it would have been obvious to include a carbon nanotube in the channel region of the device of Nakatani to reduce scattering, and thus achieve higher speed and lower noise operation.

Regarding claim 14, Nakatani fails to disclose a bundle of nanotubes.

Tsebro discloses a bundle of nanotubes (column 1, line 8).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to further modify the device of Nakatani by adding the bundle of nanotubes taught by Tsebro. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide a bundle of nanotubes in the channel region, because a single nanotube has a small volume, and thus does not allow for the transport of a large number of charge carriers. A nanotube bundle increases the volume of the channel transport region and thus increases the device speed while retaining the fermionic waveguiding properties of a quasi-one-dimensional material.

Regarding claim 15, Nakatani fails to disclose a carbon nanotube.

Tsebro discloses a carbon nanotube (column 1, lines 1-2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the device of Nakatani to include the carbon nanotube taught by Tsebro. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to specify that the nanotube is made of carbon, because carbon provides low resistivity (Tsebro, column 2, lines 1-3), which is ideal for a channel region. Additionally, efficient techniques exist for manufacturing nanotubes made of carbon (Tsebro, column 2, lines 22-25).

Regarding claim 25, Nakatani et al. disclose a magnetic head for reading data from magnetic storage media (column 1, lines 9-14).

7. Claims 11-12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakatani.

Nakatani discloses that the channel region includes a carbon containing material (column 17, lines 7-9). The carbon material is considered to include both the graphite and diamond lattice arrangements of carbon. Assuming arguendo, the carbon material of Nakatani does not include graphite or diamond.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify in the device of Nakatani, that the carbon layer includes both the graphite and diamond lattice arrangements. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to provide both diamond and graphite arrangements, because the material lattice choice directly affects the structural and electrical properties of the material. This allows the properties of the carbon to be optimized for its intended use. One of ordinary skill in the art would additionally be motivated to choose diamond or graphite carbon layers in order to optimize lattice matching with the surrounding layers. Thus, it would have been obvious to specify that the carbon layers include diamond and graphite, in order to select layer properties and promote lattice matching over a broad range.

8. Claims 16 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakatani in view of Tsebro as applied to claim13 above, and further in view of U.S. Patent No. 6,265,466 to Glatkowski et al.

As per claim 13, Nakatani as modified by Tsebro disclosed the claimed invention. See section, supra.

Regarding claim 16, Nakatani and Tsebro fail to disclose a nanotube made of boron nitride or of silicon.

Glatkowski discloses a nanotubes made of boron nitride and silicon (column 3, lines 19-21).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the magnetoelectric device of Nakatani as modified by Tsebro, such that the nanotubes are made of boron nitride or of silicon, as taught by Glatkowski. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to specify that the nanotubes can be made of boron nitride or of silicon, because boron nitride and silicon are recognized in the art as equivalent nanotube materials. It is well within the purview of one of ordinary skill in the art to select a nanotube material based on the desired material properties (column 3, lines 8-23).

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure

U.S. Patent No. 6,205,008 to Gijs et al. discloses a method of altering the ferromagnetic and channel layers of a magnetoelectric device to improve the magnetoresistance effect.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Dolan whose telephone number is (703) 305-3233. The examiner can normally be reached on Monday-Friday 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hoa T. Nguyen can be reached on (703) 305-9687. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9314 for regular communications and same for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 305-3900.

Jennifer M. Dolan
Examiner
Art Unit 2652

jmd
March 5, 2002

DAVID DAVIS
PRIMARY EXAMINER